| | | |
|---|---|---|
| University of Mansoura<br>Faculty of Engineering<br>Structural Engineering Dept. | Time: 3 Hours | Graduate Studies<br>Computer Applications<br>Final Exam |
| Any missing data may be assumed | غير مسموح باستخدام الآلة الحاسبة في حساب المعكوس | Sept., 2013 |

## Problem #1 - 20%

1. **True or False:**
   a. The **Finite Element Solution** approaches the exact one as the aspect ratio approaches zero.
   b. The **Tetrahedral** element is suitable for bodies with **complex boundaries**.
   c. Both the principle of **virtual work** and that of **minimum potential energy** are applicable for linear-elastic material behavior.
   d. Equilibrium of the whole structure is usually satisfied; **right or wrong and Why?**
   e. The **Finite Element Solution** bounds the **exact** one from above**?**
   f. The degrees of freedom per node for the **3-D** element are $u$ and $v$.
   g. The **LST** element is not generally preferred over the **CST** element.
   h. **Transformation** is not necessary for **frame elements**.
2. **Sketch** the shape function **N3** for the beam element.
3. **Sketch** the relation between **Lower-bound, Upper-bound, and Exact solutions.**

## Problem #2 - 20%

**Use anti-symmetry to simplify the beam in Fig. 1. Then, it is required to determine the nodal displacements (dy and $\phi$ at Nodes A, B, and C), sketch the deformed shape, and draw the SF and BM diagrams.**

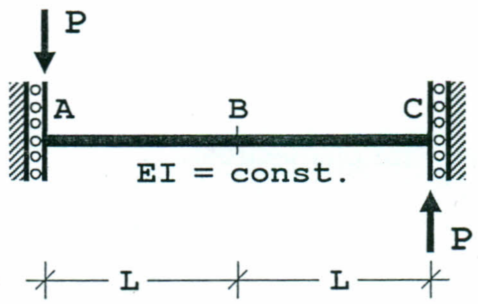


Figure-1

## Problem #3 - 20%

For the **bottom-loaded simple deep beam** shown in **Fig. 2**, **it is required to:**

1. Specify the relevant **type of analysis** to be considered.
2. Specify the appropriate **element type**.
3. Draw the **load path** (**strut-and-tie model**) and, consequently, **graph** the stress variation $\sigma_x$ along the line **y-y**.
4. Use symmetry to **simplify** the beam model and, then, apply the **boundary conditions**.
5. **Discretize** the beam with the appropriate **mesh**.

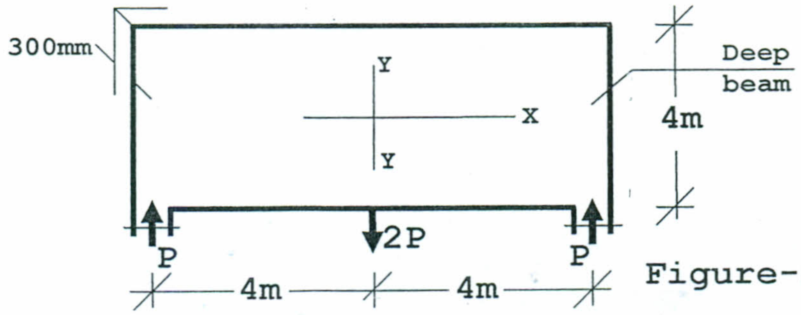


Figure-2

## Problem #4 - 40%

For the **thin steel plate** shown in **Fig. 3**, **it is required to**:

1. Specify the relevant **type of analysis** to be considered.
2. Specify the appropriate **element type.**
3. Determine the **vertical displacement** at node **A**, the **horizontal displacement** at node **B**, and the **average stresses** within the **body** of the plate under the effect of the given **load** only when:
   a. $K_{spring}$ approaches **zero**; i.e., **soft** element.
   b. $K_{spring}$ approaches **infinity**; i.e., **rigid** element. Then, **comment on your results.**
4. Draw the **deformed shape.**
   Given: **E = 200000N/mm$^2$, t = 20mm, ν = 0.30, and P = 100kN.**

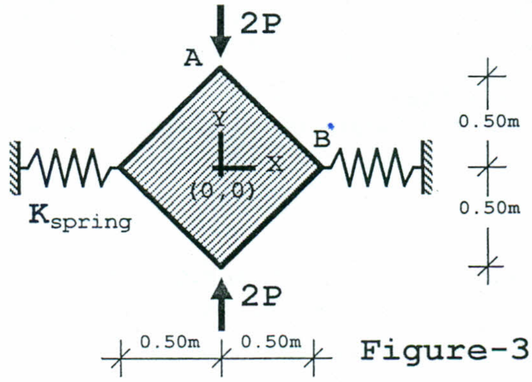


Figure-3

$$[D]=\begin{bmatrix}1 & \nu & 0\\ \nu & 1 & 0\\ 0 & 0 & \frac{1-\nu}{2}\end{bmatrix}\frac{E}{(1-\nu^2)}$$ **for plane-stress**

$$[D]=\begin{bmatrix}1-\nu & \nu & 0\\ \nu & 1-\nu & 0\\ 0 & 0 & \frac{1-2\nu}{2}\end{bmatrix}\frac{E}{(1+\nu)(1-2\nu)}$$ **for plane-strain**

Best wishes
**Dr M. EL-Zoughiby**